Tecnews

A publication for the presentation of new ideas . . . new methods . . . new products . . . in the associated fields of radio and electronics.

ELVIN W6TT
MARIO W6DUB

PUBLISHED MONTHLY BY THE ELMAR ELECTRONIC SUPPLY CORPORATION
(FORMERLY ELECTRIC SUPPLY CO.)

AUG. - SEPT. 1953

140 11th ST. OAKLAND 7, CALIF.

SIMPLIFIED PI NETWORK DESIGNS

By Clayton F. Bane, W6WB

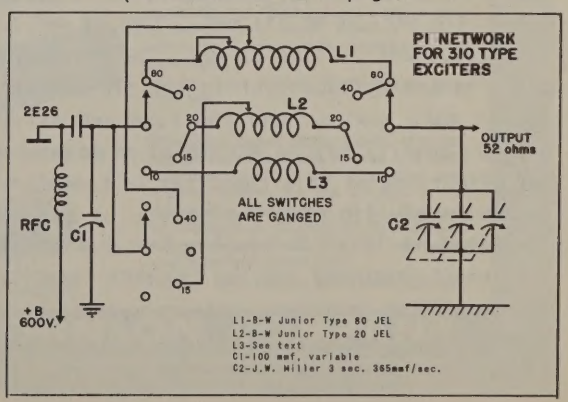
It is the purpose of this paper to briefly discuss simplified design procedure for pi networks. A six-band network for inclusion in the output circuit of a Collins 310-type exciter has been the specific design object. Since however the popular 2E26 is the output tube in this unit there is no practical reason why the same procedure cannot also be applied to any output amplifier using a 2E26. (or 6146).

The Collins 310 unit, (no longer manufactured) employs plug-in coils in the 2E26 final amplifier. The decision to substitute a pi network output circuit was based upon three factors: (1) The desire to eliminate plug-in coils, (2) The well known ability to discriminate against harmonics, (3) Wide range, variable control over loading. This latter is particularly advantageous where the exciter is to be operated directly into an antenna and used as a low powered transmitter. It is possible to employ simple bandswitching for the inductors since two of the existing B-W plug-in coils can be used as-is. (by switched-in taps). One of these coils covers 80 and 40, the other 20 and 15. An additional much smaller, self-supported coil covers 11 and 10.

The basic design of this, (or any other pi network can be greatly simplified if the output load impedance range is limited. Our own exciter works into 52 ohm line both when used to drive the output amplifier or when used as a separate low powered transmitter. That is, the feed line into the exciter is always 52 ohms; supplementary antenna couplers being used on the lower frequency ground-plane antennas. The network can be considered as working into 52 ohms although SWR on the line may result in impedances somewhat higher or lower than this figure, and a reactive component may also be present. The output circuits of the network can compensate for a considerable amount of reactance and the network constants can be readily adjusted to match impedances to 150 ohms. Loading troubles, if any will show when the actual impedance drops too low in value.

This particular network may be duplicated without need for any lengthy calculations since the value of the normally difficult-to-determine element, the inductance, can be empirically determined. It will be necessary to know the proper value of load impedance for the 2E26 and this is given to sufficient accuracy, (for a class C amplifier) by a simple, DC plate voltage/loaded DC plate current relation: In the case of the 310 exciter, the

(Continued on next page)



2E26 plate voltage is about 600 and the maximum plate current approximately 70 ma. Therefore, $\frac{600}{2 \times 70}$ x 1000 gives 4285 ohms. (Plate current is in milliamperes). The function of this network is to transform 4285 ohms to 52 ohms and it so happens that when such large impedance ratios are involved the reactance of the inductor and that of the input capacitor will be almost equal. In other words the combination will be near resonance at the design frequency when connected as a parallel resonant circuit. This doesn't mean that any LC combination that will resonate at the desired frequency will work in a pi network. There are an infinite number of such combinations but only one that will fulfill the network requirements. Obviously, either L or C must be known to determine the value of the other at the correct frequency. Network equations give these parameters in terms of reactances which are the same at all frequencies. The actual LC values to give these values of reactances must necessarily be different for each change in frequency. The value of the input capacitor, (nearest the tube), is readily determined in terms of reactance by dividing the previously determined load impedance by the loaded circuit "Q". For our purposes a Q of 12 is selected for reasons too lengthy to include in this paper, so that 4285 divided by 12 equals 357 ohms. (approx.). Capacity equivalents at different amateur frequencies are as follows: 3.5 mc, 126 mmf... 4 mc, 111 mmf... 7 mc, 63 mmf... 14 mc, 31.5 mmf... 21 mc, 21 mmf... 28 mcs, 15.75 mmf. The tuning capacitor in the 310 exciter is 100 mmf. maximum and the tube and stray wiring capacity may be estimated at about 10 mmf. The range of this capacitor is therefore approximately 110 max. and 20 min. It can be seen that it is a bit too low in capacity at the lowest frequency and has too much capacity at the highest frequency. Network operation is such however that perfectly satisfactory performance is obtained by setting the value of inductance so that the capacitor is near maximum and minimum respectively at lowest and highest bands.

Since this capacitor is a straight-line capacity type it will be possible to estimate capacity by noting the angular position of the rotor, i.e. 1/4 meshed, 40 mmf. 1/2 meshed, 65 mmf, 3/4 meshed, 85 mmf, Max. 110 mmf, Zero 20 mmf. (approx. only). Establishing the correct value of inductance is therefore a simple operation when capacity and frequency are known. Use the B-W Junior 80 meter coil for 80. Short out the output capacitor and, with the exciter set to 3.5 mcs, adjust the input capacitor until plate current dip occurs near maximum capacity. (Our coil has 11 turns shorted out). The same coil is used for 40 with a tap which is connected by one of the bandswitch wafers. Here input capacity should be 63 mmf which occurs near mid-scale setting. (23 turns are shorted out on our own coil). The B-W Junior 20 meter coil is used for 20, no turns being shorted. Capacity should be approximately 31 mmf. (Capacitor about 1/4 engaged). This same coil is used for 15 with 3 1/2 turns shorted by the appropriate bandswitch section. Capacity here is about 20 mmf, which is close to zero setting on the capacitor. The 10 or 11 meter bands use a separate coil which is wound with #12 wire on 1" diameter form and has six turns spaced out to 1". This coil is self-supported between the two bandswitch wafers. (Three Centralab "J" sections are used in this switch).

It is important to observe that the value of inductance used will have a major bearing on the loading range of the network. When the network is terminated in a non-inductive 50 ohm load, it should be possible to load the amplifier to maximum plate current or to reduce the loading to a minimum of about 20 to 30 ma.

The degree of loading (assuming a correct inductance value) is determined by the setting of the output capacitor but no values can be

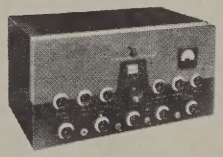
(Continued on rear page)

PPLY CORPORATION

Formerly
ELECTRIC SUPPLY CO.

Everything for a 5 by 9+ Signal

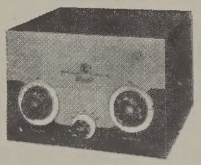
MEDIUM POWER—TVI SUPPRESSED—A COMPLETE TRANSMITTING PACKAGE FOR LESS THAN $400



VIKING II TRANSMITTER

TVI suppressed. All amateur bands from 10 to 160 meters. 100 watts phone output, 130 watts CW. Instant bandswitching with VFO input provision and dual power supplies. All stages metered. Pi-network coupling output amplifier. Self contained—no plug-in coils. 100% amplitude modulation.

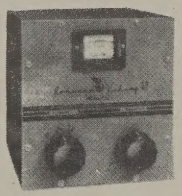
240-102 VIKING II TRANSMITTER KIT, COMPLETE WITH TUBES, LESS CRYSTALS, KEY AND MIKE. AMATEUR NET $279.50. AVAILABLE WIRED AND TESTED, $337.00 AMATEUR NET.



JOHNSON "MATCHBOX"

A fully engineered antenna coupling system, the "Matchbox" will load an almost infinite variety of antennas from 3.5 to 30.0 mcs. Matches balanced antennas from 25 to 1200 ohms resistance. Successfully loads unbalanced, or single wire antennas of approximately 25 to 3000 ohms resistance. Tunes out large amounts of reactance. Easy to use, front panel controls—no internal adjustments required to change bands.

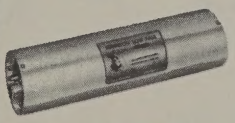
250-23 JOHNSON "MATCHBOX", ASSEMBLED, WIRED AND TESTED, $49.85 AMATEUR NET.



VIKING VFO

Accurately calibrated for all amateur bands from 10 to 160 meters. Excellent stability, vernier tuning, clean keying, and perfect "break-in" on all bands.

240-122 VIKING VFO KIT COMPLETE, LESS TUBES, $42.75 AMATEUR NET. AVAILABLE WIRED AND TESTED, $63.75 AMATEUR NET.



LOW PASS RF FILTER

Consists of four individually shielded sections, capable of handling more than 1000 watts amplitude modulated RF. Provides an additional 75 db harmonic attenuation in the antenna circuit. SO-239 coaxial connectors, completely assembled and pre-tuned.

250-20 LOW PASS RF FILTER, $16.50 AMATEUR NET.

SWR BRIDGE

Provides accurate measurements of standing wave ratios and insures the most effective use of a low pass filter and antenna coupler for the ultimate in TVI suppression. Impedance of 52 ohms can be changed to 70 ohms or other desired value. Equipped with SO-239 connectors and polarized meter jacks.

250-24 SWR BRIDGE, $9.75 AMATEUR NET.

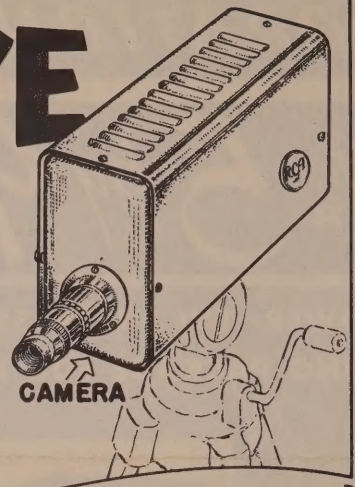
E. F. JOHNSON COMPANY

CAPACITORS, INDUCTORS, SOCKETS, INSULATORS, PLUGS, JACKS, DIALS, AND PILOT LIGHTS

TV EYE

FOR LOW COST PRIVATE WIRE TELEVISION

An amazingly compact camera (weighing less than 5 lbs.) and an ingenious control unit these constitute RCA's TV Eye. Hooked up to any 3 channels between 2 and 6 of an unaltered standard TV receiver and plugged into a 115 AC outlet, these two precision-engineered equipments are ready to carry out a thousand important remote viewing assignments. Dependable, low operating costs, negligible maintenance.



RCA

WEBSTER

Band spanner

MOBILE ANTENNA

Six band operation.

Lightweight: Total weight less than 2 pounds.

Streamlined and weather proof.

Top whip pushes completely in for storage or low door clearance.

All parts individually replaceable.

NET PRICE **29.50**

Now ..... mobile operation on 75-40-20-15-11-10 meter bands with one streamlined antenna! No external taps or projections .... no plug-in coils!!!

(Continued from inside page)

given since reactance in the external load will yield widely varying capacity settings at a given load. Suffice it to say that this capacitor must work over quite a wide range and a three section BC type capacitor, (sections parallel connected) is used. Space limitations in the 310 exciter dictate a capacitor of small dimensions and J.W.Miller #2113, (with trimmers removed) is used in our unit. The range switch is mounted on a bracket in line with the panel opening previously used for the antenna network capacitor. The Miller variable is mounted on the chassis and is driven by two pulleys with string drive to permit offset actuation from the extreme left hand panel opening formerly occupied by the coupling adjustment control. We hope to show a pic of the modification in an early issue.

Produced by C.F.Bane Advertising

Copyright 1950 by Electric Supply Co.

Elmar ELECTRONIC SUPPLY CORPORATION
(FORMERLY ELECTRIC SUPPLY CO.)

140 - 11TH STREET,
OAKLAND 7, CALIFORNIA

Sec. 34.66 P. L. & R.
U. S. POSTAGE
PAID
PERMIT NO. 759
OAKLAND, CALIF.

ANDREW H. ELSNER W6ENV
4539 BECK AVE.
NO. HOLLYWOOD, CALIF.

FORM 3547 REQUESTED